**Accelerator Systems Division Highlights Ending October 31, 2003**

**ASD/LANL: Warm Linac**

HIGH-POWER RF (WBS 1.4.1.1)
Accomplishments This Week: (1) *402.5-MHz E2V klystrons:* The factory acceptance test of SN 5 scheduled for this week was delayed. The acceptance tests are now scheduled for Nov. 17. (2) *805-MHz, 5-MW Thales klystrons:* We reached agreement with Thales for extra deliverables as payment for a reduction in specifications for the 5-MW klystron. LANL staff was at Thales for a factory acceptance test (see below). (3) *805-MHz, 550-kW Thales klystrons:* While at Thales, LANL staff witnessed the factory acceptance test of SN 7, which passed the factory tests. However, this klystron was later destroyed in packing by a Thales technician and will need to be reworked. (4) *805 MHz, 550 kW CPI tubes*: LANL has approved the test data for SN 38. Klystrons SN 35, 36, 37 and 38 were shipped directly to ORNL. (5*) 805-MHz, 5-MW Sure-Beam loads:* The Sure-Beam load that failed had its flanges re-machined, on advice from the designers. The next step is to plate the newly exposed surfaces, and we are awaiting factory authorization. (6) *805-MHz, 5-MW AFT circulators:* A circulator that had failed once was fitted with new Kapton windows, leak checked, and tested, but we again experienced arcing in the circulator, not on the windows. We are in communication with the vendor to send this circulator back to the factory. Another circulator is being prepared for testing. (7) *402.5-MHz, 2.5-MW AFT circulators:* The final circulator passed all the acceptance tests. (8) *Shipment to ORNL:* A full 40-foot truck was packed with the three 550-kW CPI klystrons, two 402.5-MHz windows, two 5-MW, 805-MHz circulators, a lifting fixture for the 5-MW klystron, a 5-MW load, a set of arc detectors, and three control racks, and send to Oak Ridge. All the RF components except the klystrons were tested at LANL. (9) *SC Transmitter:* We sent a copy of the commissioning checklist for the SC transmitter to ORNL for review. The acceptance tests of the SN 12 SC transmitter at Titan have been rescheduling for the week of Nov 3 because of the fires in California.
Concerns & Actions: (1) We had to extend the acceptance trip to Thales by several days because of a delay in the tests for the 5-MW klystron. After a considerable number of false starts, the problem was found to be a short in the focus coil that caused high, but not excessive body power in the first cavity region. After fixing the coil, the Thales test crew cautiously increased RF power in case the tube was damaged. Before we left Thales, the klystron was making full RF power at low duty factor, and the DC tests at high duty showed that the body power was down to the levels that it was at before the magnet problem. We have agreed to do a FAX,ed acceptance test in the near future and also to send a representative back to Thales in mid November, to test the next 5 MW klystron.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)
Accomplishments: (1*) Production HVCM:* We replaced the SCR driver board in the SCR controller for the production HVCM and returned it to service. (2) *Pulse-width modulation tests:* We compiled and analyzed results of pulse-width-modulation tests on a HVCM system at ORNL and prepared a summary of the results. (3) *Output ripple:* We detailed the trap network assembly that will be used too minimize output ripple.
Concerns & Actions: (1) There seems to be a continuing failure mechanism that causes surging and mis-triggers of the SCR gate driver. In addition to the production SCR at LANL, the failure of this board assembly likely caused the ORNL failure in DTL-ME2 last week. Systems operated at high power for a few months have all had SCR gate-driver card problems. We believe individual gate-driver electronics with grounded-plane PC cards and shielding

would improve the reliability. (2) We are working on start-pulse configurations to minimize back diode oscillations, core flux offset, and IGBT start currents for the SCL modulators. We will adapt the six front-panel digital set-point switches on the Z-tec DSP control chassis to provide adjustments for both the positive and negative start pulses.

DRIFT-TUBE LINAC (WBS 1.4.2)

Accomplishments – Tank 2: All drift tubes were repaired inspected and low-pressure leak checked at ESCO and are due in Los Alamos in the next two days. Five units passed a high-pressure leak check; the balance will be pressure leak-checked next week.

Tank 5: The first batch of nine Tank-5 drift tubes was shipped to ORNL this week. The balance (less one sent back for re-plating) is in Los Alamos for final processing. We will ship them to ORNL on Monday, Nov. 3.

Tank 6: Plating of Tank-6 drift tubes will be complete tomorrow (Nov. 1). We will begin final processing next week.

EMD and BPM DTs: Ten EMD drift tubes have been baked, pressure leak-checked, flow tested, and are ready for magnet flow testing and dipole field checks. Following these tests and a final bakeout, they will be shipped to ORNL. Final machining is in process on the remaining EMD drift tubes. All BPM drift tubes are mapped and are in final inspection.

Fig. 1. EMD drift tubes awaiting final tests (left) and high-pressure helium vacuum testing cart (right)

Beam boxes: Because of difficulties in compensating for weld warpage, Nov. 14 is now the earliest estimated delivery dates from the vendor for beam boxes 1/2 and 2/3. They will ship to ORNL approximately a week later. Pump grills and cover plates are at leak checking at the vendor.

Concerns & Actions: (1) There is shrinkage in the beam direction caused by the cosmetic-weld leak repairs. PMQ and empty drift tubes are short by between 0.005 and 0.017 inches. We are considering stretching them with an appliance inserted into the bore and/or plating and electro-forming, followed by machining to restore the length and profile. The techniques will be checked on test articles from Tanks 1 and 2. (2) Several EMD drift tubes failed their flow tests, and others had greater than expected pressure drop. Plugging of the cooling passages with residual Cerrobend alloy is suspected. Several methods of cleaning the tubing are being investigated.

COUPLED CAVITY LINAC (WBS 1.4.4)

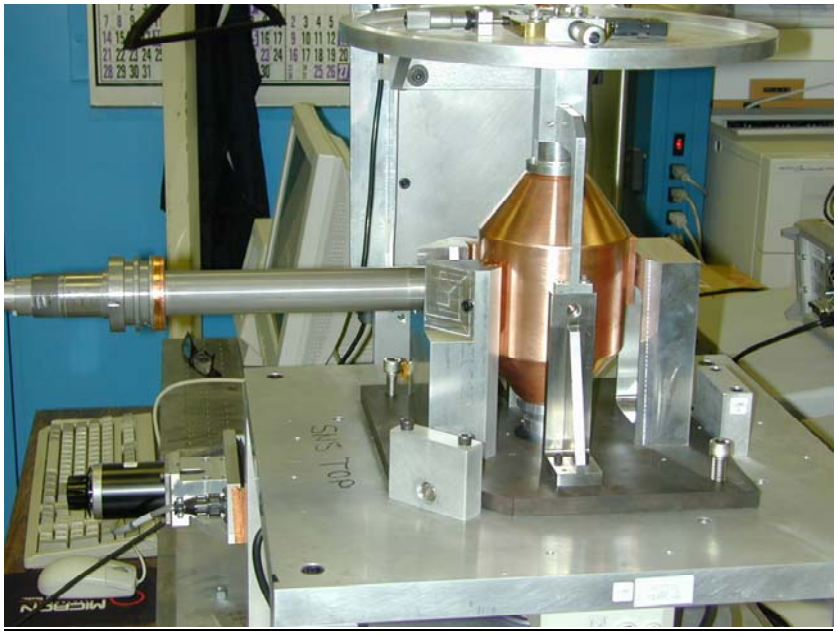
Accomplishments: (1) Tuning of CCL Module-1 was completed this week at ACCEL Instruments. The remainder of the week was spent setting getting everything set for vacuum leak testing the entire module. As of Friday morning the system was under vacuum pumping and recording a pressure of about 8.8 x 10-6 Torr. We expect to begin actual leak testing tomorrow (Nov. 1) and continue into next week.

Concerns & Actions: We continue daily technical and weekly management calls with ACCEL technical and managerial personnel. They are statusing their schedule on a regular basis, and we follow it closely. The rate of Module-2 fabrication has increased, and seven segments have been brazed as of this week, close to the promised schedule.

PHYSICS AND DIAGNOSTICS (WBS 1.4.5)

Accomplishments: (1) BPMs*:* The remaining DTL BPMs were mapped as part of the final drift-tube cleaning and inspection process, and all look good. We are upgrading the software on the DFEs in preparation for changing the operating system on the BPM electronics. (2) *Wire scanners:* We received three of the four remaining DTL wire-scanner actuators and the fourth was ready to ship when an error was discovered. They are being returned to the vendor for correction, which will delay shipping to ORNL by about a week. All DTL and CCL wire-scanner electronics and PCs were shipped and received at ORNL. (3) *Target harp:* We sent information on design of the harp pick-up to ORNL to begin.

Figure 3. BPM drift tube in final mapping (above); and DTL 6-inch-stroke wire scanner actuator (right) with protective cover over bellows (no fork installed)




**ASD/JLAB: Cold Linac**

Early results of testing on cavity #2 in cryomodule M-5 were disappointing, with low peak gradient and heavy field emission. After two shifts of conditioning, however, the peak gradient increased to just above specification and it ran there for an hour without difficulty. $Q_0$ is still below specification, but is better than it was, and is expected to improve still further with additional operation.

Two cavities (MB-26 and MB-27), processed according to the modified procedures recommended by both internal and external reviews, were qualified this week, achieving gradients 25% and 50% above specification, respectively, at the $Q_0$ specification. MB-28 is in the clean room and will be etched and high-pressure rinsed over the weekend. MB-21 (which has already failed qualification twice) will go into the clean room on Monday.

Assembly of the M-7 cryomodule is continues. The cold mass has been installed in the space frame and thermal shield.

**ASD/BNL: Ring**

Talks for the DOE Review were finalized and submitted to ASD.

Peter Ladd was at BNL this week to meet with SNS staff and discuss TiN coating, and vacuum instrumentation/controls.

Another half-cell assembly (#12) was shipped to SNS/OR.

The next half-cell (#13) is being prepared for shipment.

Extraction PFNs - Plans are being developed with our vendor, APS, to complete a 24 hr heat run before delivery of the 1st production unit to BNL for more extensive testing. Work continues at their factory on the remaining production units.

Delivery of the support stands for the two HEBT collimators has been delayed in order to allow the inclusion of additional equipment that is also ready for shipment to SNS/OR (RF junction boxes, magnet stands, vacuum chambers, etc). ETA is ~11/15.

A contract is being prepared for Rancor, the successful low bidder of the outer shielding (permanent structure) for the Ring #2 and #3 collimators.

Oak Ridge Tool and Engineering completed a "trial" stacking of the momentum collimator outer shielding. The stacked assembly was witnessed by ASD staff. Delivery to SNS/OR is scheduled for Nov. 4th.

SDMS (France) has been asked to provide a quotation for "tube shields" needed for the RTBT collimator #2.

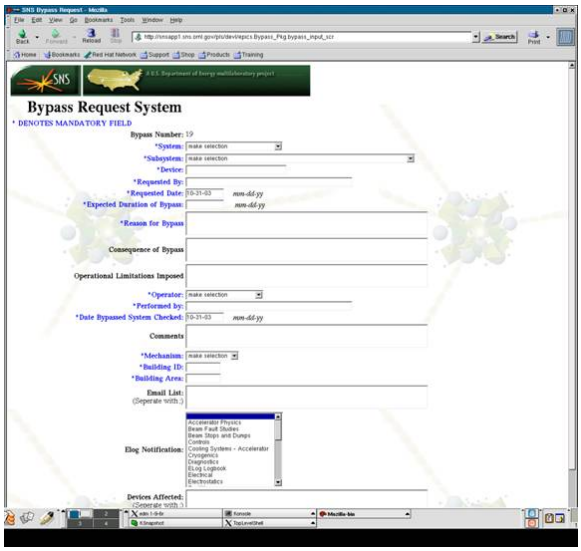
John Brodowski's retirement from BNL is effective 11/1/03.

Momentum collimator shielding

BNL resident witch

**Controls**

The Bypass request application has been reviewed and accepted by the Operations group. Effective immediately, this form will be used for tracking bypass of MPS inputs. The application will be started from a shell command EDM button. This closes out a request from the ARR committee for MPS.




Although most of the symptoms of "IOC Disease" had been eliminated by the end of last week, investigations continued and will continue until understanding is complete. There remains an unexplained level of broadcast traffic on the network which at present does not impact operations, but still requires explanation and elimination. In the meanwhile work continued on diagnosis of the archiver, which has proven unstable since its reconfiguration some weeks ago. Notwithstanding these difficulties, the control system was ready to support resumption of operations at the end of the week.

The Cryogenic Control System is on-line and supporting around-the-clock operation of the Central Helium Liquefier Purifier System. Since the facility is not manned around the clock, an automatic phone dialer was installed and tested. Selected Purifier System alarms have been configured to activate the dialer and notify CHL operations personnel that a problem exists. Through Friday afternoon, no alarms occurred. The ICS is being used to support clean-up of the main warm compressors. The ability to dynamically change the control loop process variable has helped automate this activity.

Checkout and calibration of most of the sensors and actuators on 4 of the 6 Central Helium Liquefier main compressor skids was completed. The compressor slide valves and oil pressure control valves cannot be tested until the oil pumps are running.

Personnel Protection System (PPS) PLC programming and implementation testing is continuing for the A and B programs for both phase 1 (entire Linac) and phase 1 Lite (subset of phase 1 logic and hardware). Fabrication of PPS interfaces to RF transmitters through CCL4 is 75% complete. Modification of the PPS interfaces on existing HV modulators is 50% complete. Fabrication of the last chipmunk interface panel for the Linac is also complete.

Meetings were held with the BNL RF group and ORNL controls to establish a plan for providing EPICS screens for the RF test stand being set up at ORNL. The BNL RF group is delivering all the RF equipment, a PLC-5 to provide interlocks and local control. The BNL controls group has already demonstrated the ability to use a ControlLogix PLC as a bridge between the PLC-5 and EPICS, displaying the status of the RF equipment via EDM. Between now and December, the BNL controls group will work with the BNL RF group to add the capability of writing commands from the ControlLogix PLC to the PLC-5, demonstrating appropriate levels of security and robustness. Meanwhile the BNL RF group is providing feedback on the appearance of the EDM screens, and the ORNL control

group is taking advantage of PLC experience in the PSS group to procure and set up a ControlLogix bridge identical to the one at BNL.

The BNL controls team also had a fruitful meeting with Peter Ladd of the ORNL vacuum group. The Thermo-Molecular Pumping Station (TMPS) was discussed in detail. The result was that the Ring vacuum cabling will be made identical to the LINAC vacuum cabling for the TMPS, allowing Peter to have the flexibility of enhancing the TMPS interface if necessary (e.g. to provide remote start/stop capability.) A standard for controlling open/closed valves was also worked out with operations. Ring Service Building block diagrams were updated.

Using the LANL test box, the SCL Vacuum control system has been checked with the newly repackaged vacuum I/O rack for the first of 8 vacuum racks. The I/O, database, and screens are all operational. The SCL ME1 HPRF IOC is running with Beckhoff I/O for the DC Bias Power Supplies; and motor control in the Tuner rack and the SCL Transmitter PLC are running. The SCL1 HPRF should be ready when needed although it was not tested in a final installation state. The Residual Gas Analyzer EPICS software was handed over to ORNL. Operator training is required.

**Installation**

Craft Snapshot 10/28/03

| | |
|---|---|
| ASD craft workers | 53.0 |
| Formen, ES&H, etc. | 9.0 |
| Less WBS 1.9 etc | 8.0 |
| Less absent | 2.0 |
| TOTAL | 52.0 |

An orientation was conducted in the Friday Morning Installation to update all ASD Personnel on the requirement to establish new HMIS Control Areas on site. It was also re-emphasized that old RATS I control areas must be closed out showing zero inventory. Personnel who have questions or need assistance should contact Vicky Tharpe.

Training was conducted on the revised ASD Installation Plan as it relates to the implementation of a new Appendix B. The new appendix covers the "ASD Installation Plan and Results Traveler" This training and the associated Installation Plan revision closes Action Items 552 and 552.

The 12$^{th}$ Half Cell was received from BNL and placed in the tunnel.

After check out by the Survey and Alignment Group, the third medium beta cryomodule was moved to it's position in the linac.

Ring heavy cabling is moving into the straight section. It is now anticipated that the corrector cabling will be finished in the arcs by the end of Nov. At that point, half cell installation can start again.

A high pressure test was run on the cryogenic transfer lines in the tunnel.

The start of RF testing in the SCL_ME01 system was delayed from 17NOV03 to 01DEC03 due to the CF cooling water outage which will start on the 17th. LANL has the lead role for the first SCL RF system integration and test.

**RFQ**

We installed all new fixed tuners on Monday. Resonant frequency returned to nominal value and field distribution was flat within our measurement accuracy.

Vacuum leak test went really well. After tightening several bolts here and there we obtained the same vacuum level as before repair. We still have couple of small leaks but they are old ones: one is in the vicinity of broken bolt on loop #3A and another is LEBT valve. We will fix later on.

When water system was reconnected and we started flow test, large water leak was found at the location of fixed tuner #11. It turned out that this is an old leak from manufacture defect. In order to close it special design of fixed tuner with 2 o-rings is required. It would take too long to machine new fixed tuner of proper design therefore we installed old tuner #11. It is shorter by ~2.5mm than new one but it didn't change field distribution significantly and frequency is still within our tolerance.

As soon as vacuum and water flow was reestablished we started conditioning process of the RFQ. It went really well up to 500kw, 100uS, 2Hz. At ~500kW we started to remove a lot of dirt and conditioning slowed down. Never-the-less after 6 weekend shifts we reached nominal peak field of 700kW at 200us, 2Hz, which is good for all our beam measurements and we continue to increase pulse width.

When we reached nominal peak power, we injected 36mA of beam current into the RFQ and it was transported down to the MEBT beam stop. It confirmed that we have reasonably good transmission through the RFQ and beam is accelerated. We started preparation for transporting beam through the DTL1 in order to conduct emittance measurements in the D-plate. As soon as we observe good transmission through tank1 and measure nominal emittance we can pronounce the RFQ back on line.

**Accelerator Physics**

Dry-runs for DOE accelerator physics and preops were held. Four AP group members are giving talks at the upcoming DOE Review

The parameter list was updated in preparation for the review. The most significant update is the reduction in injection dump beam power from 200 kW to 150 kW.

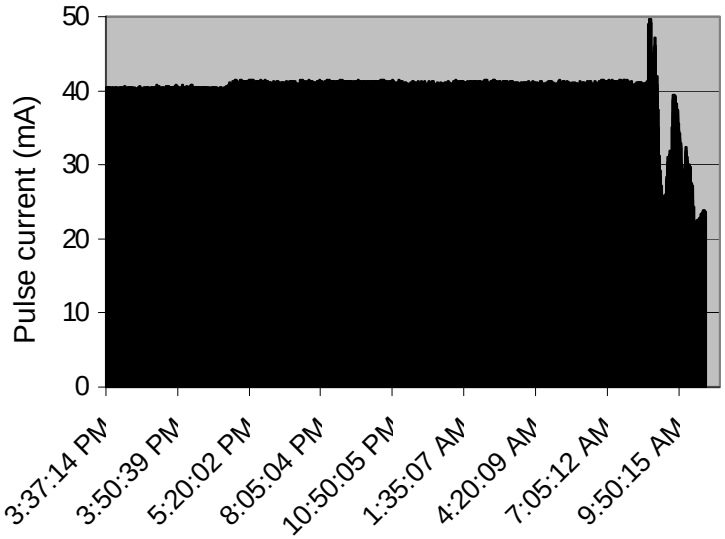
D. Jeon has simulated the expected DTL1 output beam (on D-plate) for various input beam distributions. Predicted emittance distributions are similar to observations, and show pronounced halo in the horizontal dimension.

**Operations Group**

**Ion Source Group**

Controls have made significant progress on monitoring and controlling the Ion Source Hot Spare Stand: On October 23, 2003, the beam extracted from the Hot Spare Stand has been archived until the Hot Spare Stand was switched off to install a spare LEBT. The data demonstrate the stability of the beam extracted during the night where fluctuations are less than 0.5 mA. The big fluctuations occur in the morning when the duty cycle was raised.

As suggested by the DOE review committee, the Hot Spare Stand has been equipped with a spare LEBT, shown below on the left. The first beam transversing the spare LEBT has been measured with electron-suppressing Faraday



cup in the LBNL diagnostics chamber that was also installed and is shown on the right. The LBNL chamber features also two Allison scanners that will allow us to measure the source emittance.

**Survey and Alignment**

**Mechanical Group**

The DTL-5 tank has been assembled on the support stand. Preparations are being made for leak testing which will begin next week.

DTL-5 Tank on Support Stand

The first seven DT's have been installed in DTL-4. The remaining 14 (PMQ and empty DT's) will be installed next week.

Water Systems Installation

- Installation of piping from the facility to SCL ME-02, TRCC-03 and TRCC-04 was started.
- Fabrication of SCL ME-02 Klystron body cooling line was started.
- A representative from the Victaulic piping company was on-site to review/address some joint fabrication/materials concerns.

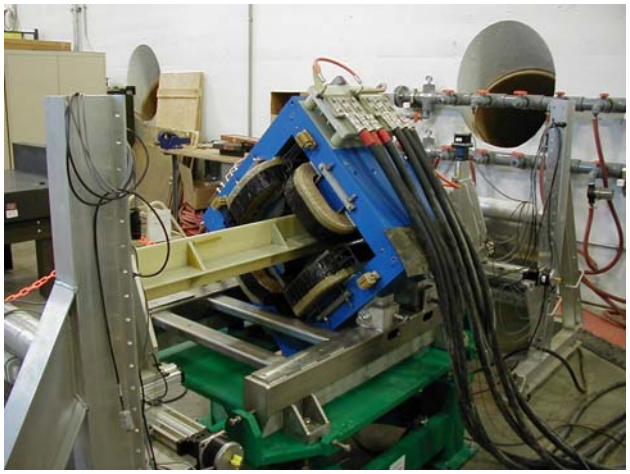
Ring Systems Installation

- The HEBT truck entrance 20 ton hoist was installed; load tested and is now ready for operation.
- The HEBT collimators' baseplates and RTBT collimator were painted.

- The HEBT momentum collimator shielding fabrication at the vendor was completed.
- The HEBT vacuum drift pipes installation continues.
- The HEBT beamline from the Linac to collimator #1 has been leak checked and is being pumped down.
- The RING half-cell #12 was received.
- DC cable pulling from the Ring Service building to the tunnel continued.

**Magnet Task**

We have made initial measurements of the first HEBT 21Q40. When we are done with the data we will publish it.



We are also continuing with CCL Quadrupole measurements. So far, we have sent 13 CCL Quads to LANL for installation of beam vacuum components. 22 CCL Quads have been delivered from Milhous. We are pressure/leak testing these quads, measuring fields, and then Error's group fiducialized them.

**Electrical Group**

Repaired SCR unit on DTL ME1. Modulator is operating in support of RFQ conditioning.

DTL ME2 & 3 operating in support of RF tests on klystrons.

SCL ME1 checkout complete. Unit has been turned over to the RF group for RF system commissioning.

Installed CCL ME3 modulator in klystron gallery.

12 Ring corrector supplies have been tested on the test stand.

2 CCL quadrupole power supplies have been tested on the test stand and installed in the klystron gallery.

Replaced faulty corrector supply used for the D-plate.

Configured test power supply (5020A, 18V) to test 21Q40 magnets for the magnet group.

Completed Ring arc heavy (535 MCM) cabling. Started Ring 6 o'clock straight section heavy cabling

**HPRF**

The E2V representative was here Wednesday through Friday to effect repairs on the 402 MHz klystrons in DTLs 4, 5, 6. The repairs were implemented. The DTL4 RF station was run full power (2.5 MW) at 20 Hz with no visible

arcing. Recommendations were made to E2V to prevent future problems in this area. DTL 5 & 6 RF stations will be tested next week.

Edward Eisen of CPI gave a one day class on klystrons to the Division. CPI supplies 81 of our 550 kW klystrons. His presentation was very useful and well received.

**LLRF**

Investigation of DMA data transfers between the FCM and the IOC is ongoing. Apparently the utility module is accessing the bus during the DMA, and the interrupt is not being handled properly. The noise spikes on the history buffers can be eliminated by delaying the DMA transfer by a few milliseconds, so that it does not coincide with utility module activities. The real fix is to ensure the hardware handles interrupts properly.

A specification for the RF Output board 50, 402.5 and 805 MHz filters was generated and sent out for bids. The previously specified filters were extremely expensive due to unnecessarily tight specification. The filter cost will likely drop by about a factor of two as a result of this change.

Hengjie and John are finishing up performance measurements on the AFE. Gain measurements were made to determine the proper resistance values on the next order of AFEs.

The procurement of electronic components for the FCM and High Power Protect Module (HPM) production is in progress. Many parts have already arrived.

Two new Rev F HPMs are expected at ORNL next week.

We are supporting the resumption of DTL1 commissioning with the turn on of RFQ this week.

The RFQ sequencer was updated to reflect the recent improvements made on the DTL sequencer. It will be installed at the beginning of next week.

**Cryosystem Group**

The helium purifier was cooled down on Tuesday. We have cleaned storage tanks 2, 3, 4, & 5. Also we have cleaned up all the first stage compressors.

The primary supply transfer line to was pressure tested to 150 PSIG

**Beam Diagnostics**

General: Preparing for DOE Review, working on handoff issues

1.5.7.1 BPM: Five combined baseband/PCI AFE/digitizer boards came from fab, and two were stuffed. Hardware and software setup for testing is underway.

1.5.7.2 IPM: Detailed design of the IPM detector head continues. Stress analysis of the vacuum chamber was completed.

1.5.7.3 BLM: No report this week.

1.5.7.4 BCM: One of the two modified rev C BCM IFEs was powered up at ORNL, with no sign of front-end problems. A virus was found on the second PC and removed. BNL ITD has suggested that this virus may actually have found its way into the PC during the previous installation at ORNL. ORNL personnel were forwarded instructions for reloading the driver for the PCI card. Initial test results of one of the rev D BCM boards are good. No additional noise observable due to the additional signal path protection. Shop fabrication of RTBT BCMs has begun. Design work for the Ring BCM continues, including stress analysis of the new housing...

1.5.7.5 Incoherent Tune: Detailed design of QMM pickup/kicker continues.

1.5.7.6 Wire Scanner: Received vacuum chamber from vendor for linac dump wire scanner. Shop fabrication of support structure has begun.

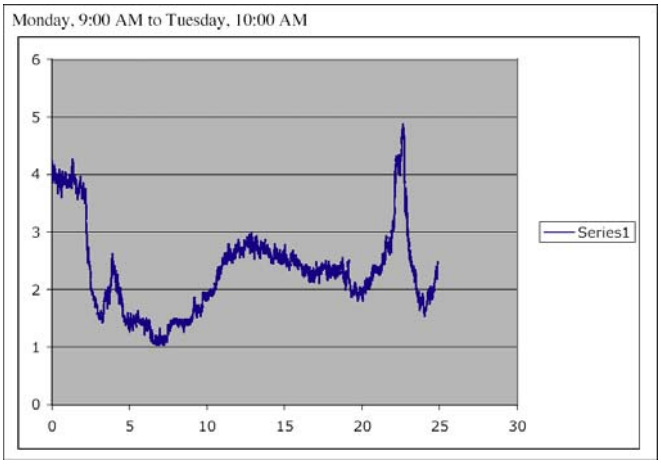
1.5.7.7 BIG/Coherent Tune: Kicker design work will resume after finishing the RTBT wire scanner design. Shop fabrication of the scrapers has begun.

ORNL SNS Beam Diagnostics Progress Report:

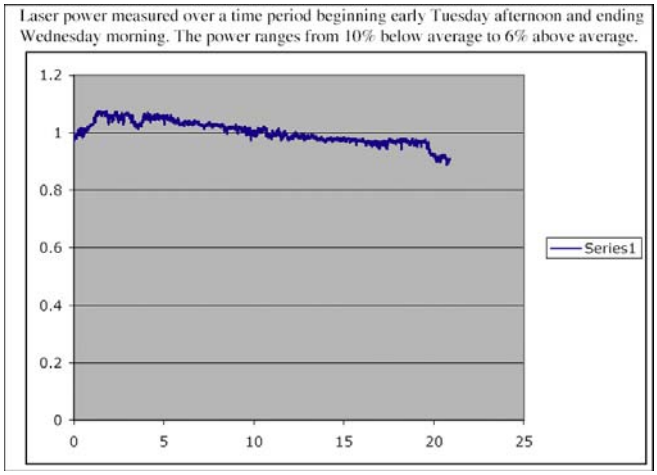
General: We will present two talks at the semi-annual DOE review covering our contributions to the commissioning and the future diagnostic installation plans.

Test Stations: Both ion chamber test station and laser magnet mapper are coming along very well. We need a couple of parts for the magnet mapper to finish that station. The XYZ stage for the BLM chamber is fully controllable via the LabVIEW Code.

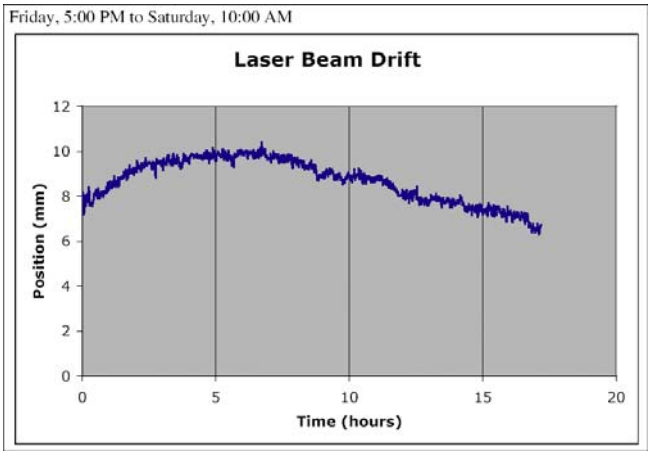
SCL Laser Profile Monitor: The transfer line (600 feet) is constructed. We are in the process of laser vibration studies. The first measurements are being performed at 150 feet from the laser room. HeNe laser is used instead of the YAG laser. 70% of the reported motion is due to the laser power. Please see the enclosed pictures.




Measured vibration during the construction activities.




HeNe Laser power drift.



Measured vibration on Sunday (No construction activities).

D-Box: Our design engineer (Tom Roseberry from the Mechanical group) is putting the finishing touches on the in-line MEBT emittance box design. The Pro-E 3-D design shows the complexity of this device.

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